Artificial Intelligence for Predictive Maintenance Applications: Key Components, Trustworthiness, and Future Trends

Abstract

Predictive maintenance (PdM) is a policy applying data and analytics to predict when one of the components in a real system has been destroyed, and some anomalies appear so that maintenance can be performed before a breakdown takes place. Using cutting-edge technologies like data analytics and artificial intelligence (AI) enhances the performance and accuracy of predictive maintenance systems and increases their autonomy and adaptability in complex and dynamic working environments. This paper reviews the recent developments in AI-based PdM, focusing on key components, trustworthiness, and future trends. The state-of-the-art (SOTA) techniques, challenges, and opportunities associated with AI-based PdM are first analyzed. The integration of AI technologies into PdM in real-world applications, the human–robot interaction, the ethical issues emerging from using AI, and the testing and validation abilities of the developed policies are later discussed. This study exhibits the potential working areas for future research, such as digital twin, metaverse, generative AI, collaborative robots (cobots), blockchain technology, trustworthy AI, and Industrial Internet of Things (IIoT), utilizing a comprehensive survey of the current SOTA techniques, opportunities, and challenges allied with AI-based PdM.